GOCE DELCEV UNIVERSITY, STIP, NORTH MACEDONIA

FACULTY OF ELECTRICAL ENGINEERING

ETIMA 2023

SECOND INTERNATIONAL CONFERENCE

27-29 SEPTEMBER, 2023

TECHNICAL SCIENCES APPLIED IN ECONOMY, EDUCATION AND INDUSTRY

УНИВЕРЗИТЕТ
ГОЦЕ ДЕЛЧЕВ
ЕЛЕКТРОТЕХНИЧКИ
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GOCE DELCEV UNIVERSITY, STIP, NORTH MACEDONIA

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PREFACE

The Faculty of Electrical Engineering at University Goce Delcev (UGD), has organized the Second International Conference ***Electrical Engineering, Informatics, Machinery and Automation - Technical Sciences applied in Economy, Education and Industry-ETIMA.***
ETIMA has a goal to gather the scientists, professors, experts, and professionals from the field of technical sciences in one place as a forum for exchanging the ideas, strengthening the multidisciplinary research and cooperation, and promoting the achievements of technology and its impact on every aspect of living. We hope that this conference will continue to be a venue for presenting the latest research results and developments on the field of technology.
Conference ETIMA was held as online conference. More than sixty colleagues contributed to this event, from five different countries with more than thirty papers.
We would like to express our gratitude to all the colleagues, who contributed to the success of ETIMA'23 by presenting the results of their current research and by launching the new ideas through many fruitful discussions.
We invite you and your colleague to attend ETIMA Conference in the future as well. One should believe that next time we will have opportunity to meet each other and exchange ideas, scientific knowledge and useful information as well as to involve as much as possible the young researchers into this scientific event.

The Organizing Committee of the Conference

ПРЕДГОВОР

Меѓународната конференција ***Електротехника, Технологија, Информатика, Машинство и Автоматика-технички науки во служба на економија, образование и индустрија-ЕТИМА*** е организирана од страна на Електротехничкиот факултет при Универзитетот „Гоце Делчев".
ЕТИМА има за цел да ги собере на едно место научниците, професорите, експертите и професионалците од полето на техничките науки и да претставува форум за размена на идеи, да го зајканува мултидисциплинарното истражување и соработка и да ги промовира технолошките достигнувања и нивното влијание врз секој аспект од живеењето. Се надеваме дека оваа конференција ќе продолжи да биде настан на кој ќе се презентираат најновите резултати од истражувањата и развојот на полето на технологијата.
Конференцијата ЕТИМА се одржа online и на неа дадоа свој придонес повеќе од шеесет автори од пет различни земји со повеќе од триесет труда.
Сакаме да ја искажеме нашата благодарност до сите колеги кои придонесоа за успехот на ЕТИМА'23 со презентирање на резултати од нивните тековни истражувања и со лансирање на нови идеи преку многу плодни дискусии.

Организационен одбор на конференцијата

СОДРЖИНА / TABLE OF CONTENTS:

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BIOMECHANICAL BEHAVIOR OF ENDOSONICS

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Abstract

Endosonics is used for root canal instrumentation and disinfection. An endosonics insert is designed to shaping and allow the traditional endodontic irrigant, sodium hypochlorite, to pass through and along the endo-sonic files. The irrigant is activated by the ultrasonic energy imparted from the energized instruments and the root canal becomes an ultrasonic bath. The ultrasonic tip vibrates at a high frequency and produces acoustic streaming and cavitation, which helps to dislodge and remove the organic and inorganic part of the smear layer and gram+ and gram – bacteria from endodontic system. This review of the literature aims at presenting the biomechanical work of endosonic in endo cavity and its clinical applications in a modern-day endodontic practice.
The following electronic databases were searched: Pubmed, Web of Sciences, Embase, Medscape, Web of Science and Cochrane Library. This study is based on review on published articles written in English language, reporting results related to biomechanical work of endosonics. The articles are full reading text, with no publication date restriction. After implementation of inclusion and exclusion criteria, from the total 104 articles, 82 articles were discarded and only 22 articles were taken for detailed analysis. A number of researchers have shown that ultrasonically assisted irrigation improves the cleaning efficiency in root canal treatments. In the study of Joyce et al., specially made endosonic dies and diamond instruments are energized by means of a Cavitron ultrasound generator (above 20 kHz frequency). Piezoelectric units have some advantages compared with earlier magnetostrictive units because they offer more cycles per second, 40 versus 24 kHz.
In summary, endosonics is a valuable tool in the field of endodontics, as it helps to improve the effectiveness of root canal treatment while reducing the need for invasive procedures. The use of endosonics in endodontics provides several benefits, including improved cleaning and shaping of the root canal system, reduced treatment time and improved treatment outcomes. Additionally, endosonics is minimally invasive and can help preserve more of the natural tooth structure, reducing the need for more extensive dental procedure. As well as explaining the endosonics biomechanical work, the work provides a basis for the further development and optimisation of the design of endosonic files.

Key words

endodontics, endosonics, ultrasonics

Introduction

Acoustic cavitation is a well-known phenomenon in the field of ultrasound [1]. It can increase mixing and fluid motion in a system, form reactive intermediates which accelerate chemical

reactions and aid in cleaning processes [2], [3]. Root canal treatment has application of ultrasound in endodontics. Here, ultrasound is applied to a narrow file which is placed within the root canal to improve the dissolution and removal of infected tissues and abscess from an infected root canal [4].

Endosonics is a particularly useful in cases where traditional endodontic techniques are not effective, such as in cases of calcified canals of root canal retreatment. It is also useful in cases where the root canal system is complex or has many branches. Endosonics in endodontics involves the use of ultrasonic energy to clean and shape the root canal system. After accessing the root canal, the ultrasonic tip is inserted into the canal system. Then the ultrasonic tip is activated. When ultrasonic nickel-titanium tip is activated, the tip vibrates at a high frequency, producing ultrasonic energy. The energy creates acoustic streaming and cavitation within the root canal, which helps to dislodge and remove debris and bacteria. Parallel to this function is irrigating the root canal. During the ultrasonic procedure, an irrigating solution is used to flush out debris and bacteria flush the root canal system. In the end, the dentist evaluate the canal, using x-rays or other imaging techniques to entire root canal system. [5], [6]

Objective: This review of the literature aims at presenting the biomechanical work of endosonic in endo cavity and its clinical applications in a modern-day endodontic practice.

Materials and methods: To reach the aim of this study, was conducted electronic research of some literature bases.

Search strategy

This review of literature was performed with analyzing 104 articles. The survey was based on electronic research of literature bases: Pubmed, Web of Sciences, Embase, Medscape, Web of Science and Cochrane Library. The articles that were reviewed are those that report results related to the ultrasonic shaping and irrigation of endodontic cavity and about our objective: biomechanical work of endosonic in endo cavity and its clinical applications in a modern-day endodontic practice.

For the search were used the following key words: ultrasonic endodontic shaping, ultrasonic endodontic irrigation, endodontics, endosonics, ultrasonics.

Criteria of inclusion and exclusion

This study is based on implementation of inclusion and exclusion criteria. Inclusion criteria were: published articles written in English language, articles reporting results related to use and biomechanical work of endosonics, articles that are full reading text, with no publication date restriction. Exclusion criteria were: duplicate articles and articles with references that are not proven.

After implementation of inclusion and exclusion criteria, from the total 104 articles, 82 articles were discarded and only 22 articles were taken for detailed analysis.

Results and discussion:

In the study of Joyce et al., specially made endosonic dies and diamond instruments are energized by means of a Cavitron ultrasound generator (above 20 kHz frequency). An endosonic insert is designed to allow the traditional endodontic irrigant, sodium hypochlorite, to pass through and along the endo-sonic files. The irrigant is activated by the ultrasonic energy imparted from the energized instruments and the root canal becomes an ultrasonic bath. Thus, endosonics is a synergistic system. The ultrasonic energy makes the files vibrate and oscillate,

facilitating the instrumentation of the root canal and, in addition, activates the irrigant for canal disinfection.

A number of researchers have shown that ultrasonically assisted irrigation improves the cleaning efficiency in root canal treatments [7]–[9]. Some argued that this was due to enhanced acoustic streaming [10]–[12] while others suggested that it could be due to the physical effects caused by cavitation [13], [14].

Table 1 Comparation of articles that have higher cleaning with different methods of biomechanical work of the endosonics

Author	Year	Higher cleaning efficiency with endosonics	Higher cleaning efficiency with acousting streaming of endosonics	Higher cleaning efficiency with cavitation of endosonics
Lee et al.	2004	✓		
Van Der Sluis et al.	2007	✓		
Violich et al.	2010	✓		
Ahmad et al.	2009		✓	
Walmsley et al.	1988		✓	
Lumley et al.	2008		✓	
Lea et al.				✓
Tiong et al.				✓

The oscillation profiles of endosonic files (i.e. files used during endodontic treatments that involve ultrasonic vibrations) have been measured to investigate correlations between the oscillation profiles and the cleaning effectiveness [15], [16]. The areas of cavitation activity around the instruments were assessed by the detection of sonochemiluminescence (SCL). Although it was reported that SCL tended to appear around the vibration antinodes of the oscillating files, there was no clear relation between the vibration amplitudes and the SCL emission [5], [6]. Furthermore, it was also reported that there was no correlation between the lengths of the endosonic files and the oscillation profiles [17]. Endosonics is an ultrasonic synergistic system of root canal instrumentation and disinfection. An endosonics is designed to allow the traditional endodontic irrigant, sodium hypochlorite, to pass through and along the endo-sonic files. The irrigant is activated by the ultrasonic energy imparted from the energized instruments and the root canal becomes an ultrasonic bath.

The term endosonics was coined by Martin and Cunningham [18], [19] and was defined as the ultrasonic and synergistic system of root canal instrumentation and disinfection. Ultrasound is

sound energy with a frequency above the range of human hearing, which is 20 kHz. The range of frequencies employed in the original ultrasonic units was between 25 and 40 kHz [20]. Subsequently the so-called low-frequency ultrasonic hand pieces operating from 1 to 8 kHz were developed [21] - [26], which produce lower shear stresses [27], thus causing less alteration to the tooth surface [28]. There are two basic methods of producing ultrasound [29] –[31]. The first is magnetostriction, which converts electromagnetic energy into mechanical energy. A stack of magnetostrictive metal strips in a handpiece is subjected to a standing and alternating magnetic field, as a result of vibrations. The second method is based on the piezoelectric principle, in which a crystal is used that changes dimension when an electrical charge is applied. Deformation of this crystal is converted into mechanical oscillation without producing heat [20]. Piezoelectric units have some advantages compared with earlier magnetostrictive units because they offer more cycles per second, 40 versus 24 kHz. The tips of these units work in a linear, back-and-forth motion, which is ideal for endodontics. Some authors [27] demonstrated that the position of nodes and antinodes of an unconstrained and unloaded endosonic file activated by a 30-kHz piezon generator was along the file length. As a result the file vibration displacement amplitude does not increase linearly with increasing generator power. This applies in particular finding the hidden canals or when removing posts and separated instruments. In addition, this motion is ideal in surgical endodontics when creating a preparation for a retrograde filling. A magnetostrictive unit, on the other hand, creates more of a figure eight elliptical motion, which is not ideal for either surgical or nonsurgical endodontic use. Themagnetostrictive units also have the disadvantage that the stack generates heat, thus requiring adequate cooling [20].

Conclusions:

In summary, endosonics is a valuable tool in the field of endodontics, as it helps to improve the effectiveness of root canal treatment while reducing the need for invasive procedures. The use of endosonics provides several benefits, including improved cleaning and shaping of the root canal system, reduced treatment time and improved treatment outcomes. Additionally, endosonics is minimally invasive and can help preserve more of the natural tooth structure, reducing the need for more extensive dental procedure. As well as explaining the endosonics biomechanical work, the work provides a basis for the further development and optimisation of the design of endosonic files.

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